Characterizing the Likelihood of Adverse Health Effects from Consuming Fish from

Lake Como

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Tarrant County, Texas

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Policy, Standards, and Quality Assurance Unit
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and
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and
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INTRODUCTION

Description of Lake Como and History of the Extant Possession Ban

Owned and operated by the City of Fort Worth, Lake Como is a small urban storm-water retention pond that receives non-point source runoff from nearby areas. The pond is located in *Lake Como Park*, just off Bourine Road, south of Interstate 30 west of U.S. 377, in one of the older residential areas of Fort Worth, Tarrant County, TX,[1] the seat of Tarrant County government, and a part of the Dallas-Fort Worth-Arlington Metropolitan Statistical Area. In the year 2000, the census bureau reported the population of the "Metroplex" – the Dallas-Fort Worth-Arlington area – to be 5,161,544 persons.[2, 3] Lake Como was stocked by the Texas Parks and Wildlife Department (TPWD) in 1977 with largemouth bass and, in the early 1990's, with channel catfish.[4] Since 1995 or earlier, perhaps coincidental to Aquatic Life Order #10 issued by the then Texas Department of Health (TDH), the Texas Parks and Wildlife Department (TPWD) has not stocked Lake Como.[4]

In March of 1995, the Division of Seafood Safety released a report entitled *Results and Risk Assessment for Fish Tissue Collected from Lake Como.* After finding elevated levels of chlordane and other contaminants in fish from Lake Como, the city of Fort Worth requested that TDH collect and analyze fish from Lake Como to confirm that city's findings. TDH analyzed fifteen fish, including largemouth bass, white crappie, and catfish. Samples were analyzed for metals, PCB's, and pesticides. The data in that survey indicated that the metals observed in those fish were of no concern to public health. On the other hand, the probability of excess cancers and excess likelihood of systemic effects from organic contaminants including chlordane, DDT, DDE, DDD, and Aroclor 1260 was elevated for people who ate fish from Lake Como, exceeding TDH criteria for issuance of fish consumption advice or a closure order. On December 5, 1995, based on the results of the 1994 samples, the Commissioner of Health for the State of Texas issued Aquatic Life Order #10 (AL-10), prohibiting possession of fish from Lake Como.[5]

In 2001 and 2002, fish from Lake Como were again evaluated (2nd assessment) for contamination. Laboratory analyses of samples collected from the pond during this evaluation revealed that toxicants identified in the 1995 study were still present in the 2001-2002 samples, but only at levels that should cause no risk to human health. However, because the only fish species sampled during this survey were largemouth bass, in contrast to the 1995 survey, risk assessors at TDH recommended AL-10 remain in effect in anticipation of collection and analysis of other fish species from this urban storm-water retention pond. Risk managers agreed; therefore, Aquatic Life Order #10 remains in force at Lake Como as of March 2007.

The Seafood and Aquatic Life Group (SALG) of the Department of State Health Services (DSHS, formerly the Texas Department of Health) – with funding from the Total Maximum Daily Load (TMDL) Program of the Texas Commission on Environmental Quality (TCEQ) – collected fish in 2005 for the third time in 10 years. SALG risk assessors utilized analytical data from those samples for the present report (3rd assessment). This report describes the results of the 2005 evaluation of fish from Lake Como, addresses changes, if any, in findings in fish from the pond, presents conclusions from the study, and addresses the implications to public health of consumption of fish from this lake.

The Total Maximum Daily Load Program (TMDL Program) at the Texas Commission on Environmental Quality (TCEQ) and the Influence of the Department of State Health Services (DSHS) Consumption Advisories or Possession Bans on the TMDL Program.

The TCEQ enforces federal and state laws that promote judicious use of water bodies under the jurisdiction of the state and protects state-controlled water bodies from pollution. Pursuant to the federal Clean Water Act, Section 303(d),[6] all states must establish a "total maximum daily load" (TMDL) for each pollutant contributing to the impairment of a water body for one or more designated uses. A "TMDL" is the sum of the allowable loads of a single pollutant from all contributing point and non-point sources, and including a margin of safety to ensure the water body can be used for all its designated purposes, and accounting for seasonal variation in water quality. States, territories, and tribes define the uses for a specific water body (e.g., drinking water, contact recreation, aquatic life support [fish consumption], along with the scientific criteria used to support each specified use). The Clean Water Act, section 303, promulgates water quality standards, orders the establishment of TMDLs, and implementation plans.[6]

When the Department of State Health Services (DSHS) acts to restrict consumption of fish from a water body because of the presence of toxic substances in the fish, the water body is placed on a "draft" 303(d) List[6] compiled by the TMDL Program. TMDL staff members then prepare TMDLs for all contaminants capable of negatively affecting human health if consumed in contaminated fish, followed, upon approval, by an Implementation Plan – a "remediation" plan, if you will – for each contaminant. Upon implementation, these plans facilitate rehabilitation of the water body, which (in Lake Como's case would restore the taking of fish from the pond). For Lake Como, staff at TCEQ prepared TMDLs for chlordane, dieldrin, DDE, and PCBs. The TCEQ adopted the TMDLs for Lake Como fish pollutants. The Region VI office of the United States Environmental Protection Agency (USEPA; EPA) approved the TMDLs. Fish consumption is a recognized use for many reservoirs. Thus, a water body is impaired if fish from the water body are contaminated with toxicants that make those fish unfit for consumption. A water body, and the aquatic flora and fauna living there, may clear itself of toxicants over time after removal of the source(s). Alternatively, the water body may undergo some form of remediation (such as TMDL activities), after which people may once again take fish from that water body. One of several items on the Implementation Plans for water bodies on the 303(d) list consists of the periodic reassessment of contaminant levels in resident fish.

Subsistence Fishing at Lake Como

The USEPA suggests that, along with ethnic characteristics and cultural practices of an area's population, the poverty rate could contribute to any determination of the rate of subsistence fishing in an area.[7] The USEPA and the DSHS believe it important to consider subsistence fishing to occur at any water body because subsistence fishers (as well as recreational anglers and certain tribal and ethnic groups) usually consume more locally caught fish than the general population. These groups sometimes harvest fish or shellfish from the same water body over many years to supplement caloric and protein intake. Should local water bodies contain chemically contaminated fish or shellfish, people who routinely eat fish from the water body or those who eat large quantities of fish from the same waters, could increase their risk of adverse health effects. The USEPA suggests that states assume that at least 10% of *licensed* fishers in any area are subsistence fishers. Lake Como is in a community park near large, old neighborhoods. Recreational fishing was once encouraged, as shown by historical stocking practices. Subsistence fishing, while not explicitly documented by the DSHS, likely occurs. The DSHS assumes the rate of subsistence fishing to be similar to that estimated by the USEPA.[7]

METHODS

Fish Tissue Collection and Analysis

The DSHS Seafood and Aquatic Life Group (SALG) collects and analyzes edible fish from the state's public waters to evaluate potential risks to the health of people consuming contaminated fish or shellfish. Fish tissue sampling follows standard operating procedures from the DSHS *Seafood and Aquatic Life Group Survey Team Standard Operating Procedures and Quality Control/Assurance Manual.*[8] The SALG bases its sampling and analysis protocols, in part, on procedures recommended by the United States Environmental Protection Agency (EPA) in that agency's *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisories, Volume 1.*[9] Advice and direction are also received from the legislatively mandated *State of Texas Toxic Substances Coordinating Committee (TSCC) Fish Sampling Advisory Subcommittee (FSAS).*[10] Samples usually represent species, trophic levels, and legal-sized specimens available for consumption from a water body. When practical, the DSHS collects samples from two or more sites within a water body to better characterize geographical distributions of contaminants.

Description of the Lake Como 2005 Sample Set

In November 2005, SALG staff collected 10 fish samples from Lake Como. Risk assessors used data from these fish to assess the potential for adverse human health outcomes from consuming fish from this lake.

Because Lake Como (10.1 acres) is small, the SALG did not select sample sites to provide spatial coverage of the study area; rather, the group utilized the entire lake as a single "site" (Figure 1). The SALG targeted species for collection from Lake Como through fish-tissue sampling protocols developed over many years by the SALG and it's legacy group, the Division of Seafood Safety at the legacy department the Texas Department Health (now the Department of State Health Services). Species collected represent distinct ecological groups (i.e. predators and bottom-dwellers) that have some potential to bio-accumulate chemical contaminants, have a wide geographic distribution, are of local recreational fishing value, and/or that anglers and their families commonly consume. The 10 fish collected from Lake Como in November 2005 represented all species targeted for collection from this water body (Table 1). Targeted species and numbers collected are listed in descending order: largemouth bass (8), channel catfish (1), and common carp (1).

During each day of sampling, staff set gill nets in late afternoon and fished those overnight, collecting samples from the nets early the following morning. Gill nets were set to maximize available cover and habitat in the lake. SALG staff stored captured fish retrieved from the nets on wet ice until processed. The staff returned to the lake any remaining live fish culled from the catch. Staff also properly disposed of fish found dead in the gill nets.

The SALG utilized a boat-mounted electrofisher to collect fish. SALG staff conducted electrofishing activities during daylight hours, using pulsed direct current (Smith Root 7.5 GPP electrofishing system settings: 4.0-6.0 amps, 60 pulses per second [pps], low range 360 volts, 80% duty cycle) to stun fish that crossed the electric field in the water in front of the boat. Staff used dip nets over the bow of the boat to retrieve stunned fish, netting only fish pre-selected as target samples. Staff immediately stored retrieved samples on wet ice in large coolers to ensure interim preservation.

SALG staff processed fish on site at Lake Como. Staff weighed each sample to the nearest gram on an electronic scale and measured total length (tip of nose to tip of tail fin) to the nearest millimeter. After weighing and measuring a fish, staff used a cutting board covered with aluminum foil and a fillet knife to prepare one or two skin-off fillets from that fish. The foil was changed and the filleting knife cleaned with distilled water after each sample was processed, after which the wrapped the fillet(s) was wrapped in two layers of fresh aluminum foil, placed in a clean pre-labeled plastic freezer bag, and stored on wet ice in an insulated chest until further processing. At the end of the sampling trip, SALG staff transported tissue samples on wet ice to their Austin, TX, headquarters, where the samples were stored temporarily at -5° Fahrenheit (-20° Celsius) in a locked freezer. The freezer key is accessible only to authorized SALG staff members to ensure the chain of custody is unbroken while samples are in the possession of agency staff.

Analytical Laboratory Information

During the week following sample collection, the SALG used overnight shipping by common carrier to deliver all ten samples (skin-off fillets) frozen on ice (wet) to the Geochemical and Environmental Research (GERG) Laboratory, Texas A&M University, College Station, TX, for contaminant analysis. The SALG staff requested that GERG use USEPA-sanctioned methods to analyze the fillets from Lake Como for common inorganic and organic contaminants. The request included seven metals – total arsenic, cadmium, copper, lead, total mercury, selenium, and zinc – as well as panels of volatile organic compounds (VOCs); semivolatile organic compounds (SVOCs); pesticides representing several classes of pesticides: organophosphates, organochlorines, and carbamates; and 209 possible polychlorinated biphenyl congeners (PCBs). At SALG's request, the laboratory analyzed only two of the original ten samples for SVOCs and VOCs.[a]

GERG notified the SALG upon receipt of the samples from Lake Como, recording the DSHS sample number and the condition of each tissue sample upon receipt.

The GERG laboratory reports the presence and concentrations of 209 PCB congeners using detection limits that are, typically, around 1 µg/kg. Although only about 130 congeners existed in mixtures commonly used in the U.S. (Aroclors), it may be useful to have measured all 209

[a] As suggested by the USEPA, the GERG laboratory analyzed fish tissue for PCB congeners rather than for Aroclors. The GERG laboratory was selected to analyze fish tissue when the previous laboratory overcommitted its services. The methodology for measuring congeners has a lower method detection limit (MDL) than measurements of Aroclors. Thus, PCB congeners may be detected where Aroclors might not have been observed (MDL-congeners = circa 1 mcg/kg vs MDL –Aroclors =40 mcg/kg). USEPA-sanctioned methods for other contaminants are not known to have varied from those employed by the previous laboratory.

congeners for examining the effects of "weathering" on the PCB mixture presumed originally disseminated.

Despite the suggestion by EPA that states utilize PCB congener analysis, rather than Aroclor or homolog analyses, the toxicity literature does not reflect this state-of-the-art laboratory science, making it somewhat difficult for states to determine the toxicity of congeners identified in fish tissues. To handle this dilemma, DSHS empirically uses recommendations from the National Oceanic and Atmospheric Administration (NOAA)[11] and from McFarland and Clarke,[12] along with the USEPA's guidance documents for assessing contaminants in fish tissues[9,13] to address the toxicity of PCB congeners in fish tissues, summing concentrations of 43 PCB congeners to derive a "total" PCB concentration. The DSHS uses the data on total PCBs to derive an average concentration of PCBs to determine the possibility of adverse health outcomes from consuming PCBs in fish. The authors of the preceding references utilized congeners for the likelihood of occurrence in fish, the likelihood of significant toxicity – based on structure-activity relationships, – and for the relative environmental abundance of those congeners.[11, 12] Using only a few PCB congeners to determine "total PCBs" could underestimate PCB concentrations in fish tissue. Nonetheless, this method complies with expert recommendations on evaluation of PCB toxicity. SALG risk assessors compared average PCB concentrations with information in the USEPA's IRIS database.[14] IRIS currently contains information on the toxic effects, RfDs, CPFs and other information for five Aroclor mixtures: Aroclor 1016, 1242, 1248, 1254, and 1260 (not all information is available for all the mixtures) as well as combined PCBs.[14] Systemic toxicity estimates in this document reflect comparisons with the RfD for Aroclor 1254, for instance, because IRIS contains an RfD for Aroclor 1254 but not for Aroclor 1260. As of yet, IRIS does not contain toxicity information on individual PCB congeners. Risk assessors may not have been able to determine which Aroclor mixture was originally present, or, indeed, if the PCBs observed even originated from Aroclor mixes – U.S. companies used PCB mixtures imported from other countries and airplanes and ships from foreign countries entered U.S. waters. Those vessels could have discharged foreign-made PCB mixtures into U.S. portal waters.

The potency of PCB mixtures to cause cancer in exposed individuals is determined using a tiered approach that depends on information available from the federal government (the USEPA's IRIS database).[14] Three tiers of carcinogen slope factors (SFs) used to assess the impact of environmental PCBs exist. The first tier, with an upper bound slope factor of 2.0 and a central tendency slope factor of 1.0, is used for PCBs with "high risk and persistence." Criteria for using this most restrictive slope factor include exposure via food, ingestion of sediment or soil, inhalation of dust or aerosols, dermal exposure – if an absorption factor was applied – the presence of dioxin-like, tumor-promoting, or persistent PCB congeners, and early-life exposure. Because of the potential implications of early-life exposures, including factors such as possibly greater perinatal sensitivity, or the likelihood of interactions between thyroid hormone levels (depleted by PCBs in some studies) and development, it is reasonable to conclude that early-life exposures may be associated with increased risks. Because of the potential for greater risk from exposures to PCBs that occur earlier in life, the DSHS, in agreement with the USEPA, utilizes the "high risk" tier for all early-life exposures.[14]

The GERG laboratory analyzed each of ten fish for total (inorganic arsenic + organic arsenic = total) arsenic.[b] The SALG, taking a conservative approach, estimates 10% of the total arsenic in any fish is inorganic arsenic, deriving estimates of inorganic arsenic concentrations by multiplying reported total arsenic concentration/fish by a factor of 0.1.[15]

Nearly all mercury in upper trophic level fish three years of age or older is methylmercury.[6] Thus, the total mercury concentration in a fish of legal size for possession in Texas serves well as a surrogate for methylmercury concentration. Because methylmercury analyses are difficult to perform well and are more expensive than analysis of total mercury, the USEPA recommends that states determine total mercury concentration in a fish and that – to protect human health – states conservatively assume that all reported mercury in fish or shellfish is methylmercury. The GERG laboratory thus analyzed fish tissues for total mercury. In its risk characterizations, DSHS compares mercury concentrations in tissues to a comparison value derived from the ATSDR's minimal risk level for methylmercury.[16] (In these risk characterizations, the DSHS may interchangeably utilize the terms "mercury", "methylmercury", or "organic mercury" to refer to methylmercury in fish).

Statistical Analysis

SALG risk assessors employed SPSS® statistical software, version 13.0 installed on IBM-compatible microcomputers (Dell, Inc) to generate descriptive statistics (mean, standard deviation, median, range, and minimum and maximum concentrations) on all measured compounds in each species of fish from each sample site.[17] SALG risk assessors utilized ½ the detection limit for all analytes not detected (ND) or estimated (J)[c] concentrations in computing descriptive statistics. SALG risk assessors imported previously edited Excel data files into SPSS® to generate means, standard deviations, median concentrations, and minimum and maximum concentrations of each measured analyte. SALG used the descriptive statistical results to generate the present report. SALG protocols do not require hypothesis testing. Nevertheless, when data are of sufficient quantity and quality, and, should it be necessary, the SALG utilizes SPSS® software to determine significant differences in contaminant concentrations among species and/or collection sites. The SALG risk assessors did not test hypotheses on differences among species from Lake Como because sample size was small and numbers of samples of each species were limited. The SALG employed Microsoft Excel® spreadsheets to generate figures, to compute health-based assessment comparison values (HAC_{nonca}) for contaminants, and to calculate hazard quotients (HQ), hazard indices (HI), cancer risk probabilities, and meal consumption limits for fish from Lake Como.[18] When lead data are of sufficient quality, concentration, and interest, the SALG utilizes the USEPA's Interactive Environmental Uptake Bio-Kinetic (IEUBK) model to determine whether, if consumed, certain concentrations of lead in fish could cause children's blood lead (PbB) level to exceed 10 micrograms/deciliter. A blood lead greater than 10 mcg/dL is the concentration designated by the Centers for Disease Control and Prevention to be of concern to the health of children exposed to environmental lead.[19]

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[b] Although the proportions of each form of arsenic may differ among species, under different water conditions, and, perhaps, with other variables, the literature suggests that well over 90% of arsenic in fish is likely organic arsenic – a form of arsenic that is virtually non-toxic to humans.

[c] "J-value" is standard laboratory nomenclature for analyte concentrations that are detectable in a sample, but are considered "estimates." Quantitation may be suspect because those concentrations lie on a part of the standard curve that is not linear.

Derivation and Application of Health-Based Assessment Comparison Values (HACs)

The effects of exposure to any hazardous substance depend on the dose, the duration of exposure, the manner in which one is exposed, one's personal traits and habits, and whether other chemicals are present.[20] People who regularly consume contaminated fish or shellfish conceivably suffer repeated exposures to relatively low concentrations of contaminants over extended times. Such exposures are unlikely to result in acute toxicity but may increase risk of subtle, chronic, and/or delayed adverse health effects that include cancer, benign tumors, birth defects, infertility, blood disorders, brain damage, peripheral nerve damage, lung disease, and kidney disease, to name but a few.[20] Presuming people to eat a diet of diverse fish or shellfish from a water body if species variety is available, the DSHS routinely collapses data across species and sampling sites to evaluate mean contaminant concentrations of toxicants in all samples. This approach intuitively reflects consumers' likely exposure over time to contaminants in fish or shellfish from a water body, but may not reflect reality at a specific water body. The agency thus reserves the right to examine risks associated with ingestion of individual species of fish or shellfish from separate collection sites or at higher concentrations (e.g., the upper 95 percent confidence limit on the mean concentration. Confidence intervals are derived from Monte Carlo simulation techniques with software developed by Dr. Richard Beauchamp, of the DSHS).[21] The DSHS evaluates contaminants in fish by comparing the mean, and – when appropriate – the 95% upper confidence limit on the mean concentration of a contaminant to its health-based assessment comparison (HAC) value (measured in milligrams of contaminant per kilogram of edible tissue – mg/kg) derived for non-cancer or cancer endpoints. To derive HAC values for systemic (HAC_{nonca}) effects, the department assumes a standard adult weighs 70 kilograms and that adults consume 30 grams of edible tissue per day (about one 8-ounce meal per week). The DSHS uses EPA's oral reference doses (RfDs)[22] or the Agency for Toxic Substances and Disease Registry's (ATSDR) chronic oral minimal risk levels (MRLs)[23] to generate HAC values used in evaluating systemic (noncancerous) adverse health effects. The USEPA defines an RfD as

> *An estimate of a daily oral exposure for a given duration to the human population (including susceptible subgroups) that is likely to be without an appreciable risk of adverse health effects over a lifetime.*[24]

EPA also states that the RfD

> *… is derived from a BMDL* (benchmark dose lower confidence limit)*, a NOAEL* (no observed adverse effect level)*, a LOAEL* (lowest observed adverse effect level)*, or another suitable point of departure, with uncertainty/variability factors applied to reflect limitations of the data used. [Durations include acute, short-term, subchronic, and chronic and are defined individually in this glossary]"* and *"RfDs are generally reserved for health effects thought to have a threshold or a low dose limit for producing effects.*[24]

The ATSDR uses a similar technique to derive *minimal risk levels* (MRLs).[23] The DSHS compares the estimated daily dose (mg/kg/day) – derived from the mean of the measured concentrations of a contaminant – to the contaminant's RfD or MRL, using hazard quotient (HQ) methodology as suggested by the USEPA.

A HQ, defined by the EPA, *is*

> *…the ratio of the estimated exposure dose of a contaminant (mg/kg/day) to the contaminant's RfD or MRL (mg/kg/day).*[25]

Note that a linear increase in the hazard quotients for a site or species usually does *not* represent a linear increase in the likelihood or severity of systemic adverse effects (i.e., a substance having an HQ of 2 is not twice as toxic as if the substance had an HQ of 1.0. Similarly, a substance with a HQ of 4 does not imply that adverse events will be four times more likely than a HQ of 1.0). As stated by the EPA, a HQ (or an HI) of less than 1.0 "is no cause for concern, whereas an HQ (or HI) greater than 1.0 should indicate some cause for concern." Thus, risk managers at DSHS utilize a HQ of 1.0 as a "jumping-off point," not to make decisions concerning the likelihood of occurrence of adverse systemic events, but as a point of departure for management decisions that assume, in a manner similar to EPA decisions, that fish or shellfish having a hazard quotient of less than 1.0 are unlikely to be cause for concern. Since the chronic oral RfD derived by the USEPA represents chronic consumption, eating fish with a toxicant-to-RfD ratio (the HQ) of less than 1.0 is not likely to result in adverse health effects, whereas routine consumption of fish where the HQ for a specific chemical exceeds 1.0 represents a qualitatively unacceptable increase in the likelihood of systemic adverse health outcomes.

Although DSHS preferentially utilizes a reference dose (RfD) derived by federal scientists for each contaminant, should no RfD be available for a specific contaminant, the USEPA advises risk assessors to consider using a reference dose determined for a contaminant of similar molecular structure, or mode or mechanism of action. For instance, DSHS – as specifically directed by the USEPA – uses the published reference dose for Aroclor 1254 to assess noncarcinogenic effects of Aroclor 1260, for which no reference dose is available – the USEPA has derived one other reference dose for Aroclors – that of Aroclor 1016. However, Aroclor 1016 is not as clearly like Aroclor 1260 as is Aroclor 1254. In the past, when DSHS had access only to the relatively crude measurement of Aroclors, the agency did not attempt to determine the dioxin equivalent toxicity of coplanar PCBs found in fish. The SALG recently adopted PCB congener analysis, as is suggested by the USEPA. This change in methodology allows the agency to identify coplanar or dioxin-like PCBs and to apply toxicity equivalency factors (TEFs) to PCBs in fish should this option become a priority.

The constants (RfDs, MRLs) the DSHS employs to calculate HAC_{nonca} values are derived by federal agencies from the peer-reviewed literature (which the federal agencies routinely re-examine). These values incorporate built-in margins of safety called "uncertainty factors" or "safety factors" as mentioned in EPA reference materials.[24] In developing oral RfDs and MRLs, federal scientists review the extant literature to determine experimentally-derived NOAELs, LOAELs, or BMDs, then utilize uncertainty factors to minimize potential systemic adverse health effects in people who are exposed through consumption of contaminated materials by accounting for certain conditions that may be undetermined by the experimental data: extrapolation from animals to humans (interspecies variability), intra-human variability, use of a subchronic study rather than a chronic study to determine the NOAEL, LOAEL, or BMD, and database insufficiencies.[22] Vulnerable groups – women who are pregnant or lactating, women who may become pregnant, the elderly, infants, children, people with chronic illnesses, those with compromised immune systems, or those who consume exceptionally large servings, called "sensitivities" by the EPA, also receive special consideration in calculations of the RfD.[24, 26]

The DSHS calculates cancer-risk comparison values (HAC_{ca}) from the EPA's chemical-specific cancer potency factors (CPFs) – also known as slope factors (SFs) – derived through mathematical modeling of carcinogenicity studies. For carcinogenic outcomes, the DSHS calculates a theoretical lifetime excess risk of cancer for specific exposure scenarios for carcinogens, using a standard 70-kg body weight and assuming an adult consumes 30 grams of edible tissue per day. The SALG risk assessors incorporate two additional factors into determinations of theoretical lifetime excess cancer risk: (1) an acceptable lifetime risk level (ARL) [24] of one excess cancer case in 10,000 persons whose average daily exposure is equal and (2) daily exposure for 30 years. Comparison values used to assess the probability of cancer, thus, do not contain "uncertainty" factors as such. However, conclusions drawn from those probability determinations infer substantial safety margins for all people by virtue of the models utilized to derive the slope factors (cancer potency factors).

Because the calculated comparison values (HAC_{nonca} and HAC_{ca}) are quite conservative, adverse systemic or carcinogenic health effects are unlikely to occur, even if exposures are consistently greater or for longer times than those used for comparison values. Moreover, comparison values for adverse health effects (systemic or carcinogenic) do not represent sharp dividing lines (bright-line divisions) between safe and unsafe exposures. The *perceived* strict demarcation between acceptable and unacceptable exposures or risks is primarily a tool to assist risk managers to make decisions that *ensure* protection of the public's health. For instance, the DSHS considers it unacceptable when consumption of four or fewer meals per month of contaminated fish or shellfish would result in *exposure* to contaminant(s) in excess of a HAC value or other measure of risk *even* though most such exposures are unlikely to result in adverse health effects. The department further advises people who wish to minimize exposure to contaminants in fish or shellfish to eat a variety of fish and/or shellfish and to limit consumption of those species most likely to contain toxic contaminants. DSHS aims to protect vulnerable subpopulations with its consumption advice. The DSHS assumes that advice protective of vulnerable subgroups will also minimize the impact to the general population of consuming contaminated fish or shellfish.

Children's Health Considerations

The DSHS recognizes that fetuses, infants, and children may be uniquely susceptible to the effects of toxic chemicals and suggests that exceptional susceptibilities demand special attention.[27, 28] Windows of special vulnerability; known as "critical developmental periods," exist during development. Critical periods occur particularly during early gestation (weeks 0 through 8), but can occur at any time during pregnancy, infancy, childhood, or adolescence – indeed, at any time during development – times when toxicants can impair or alter the structure or function of susceptible systems.[29] Unique early sensitivities may exist because organs and body systems are structurally or functionally immature – even at birth – continuing to develop throughout infancy, childhood, and adolescence. Developmental variables may influence the mechanisms or rates of absorption, metabolism, storage, or excretion of toxicants, any of which factors could alter the concentration of biologically effective toxicant at the target organ(s) or that could modulate target organ response to the toxicant. Children's exposures to toxicants may be more extensive than adults' exposures because, in proportion to their body weights, children consume more food and liquids than do adults do, another factor that might alter the concentration of toxicant at the target. Infants can ingest toxicants through breast milk – an exposure pathway that often goes unrecognized (nonetheless, the advantages of breastfeeding outweigh the probability of significant exposure to infants through breast milk. Women are encouraged to continue breastfeeding and to limit exposure of their infants by limiting intake of the contaminated foodstuff). Children may experience effects at a lower exposure dose than might adults because children's organs may be more sensitive to the effects of toxicants. Stated differently, children's systems could respond more extensively or with greater severity to a given dose than would an adult organ exposed to an equivalent dose of a toxicant. Children could be more prone to developing certain cancers from chemical exposures than are adults.[30] In any case, if a chemical – or a class of chemicals – is observed to be – or is thought to be – more toxic to the fetus, infants, or children than to adults, the constants (e.g., RfD, MRL, or CPF) are usually further modified to assure protection of the immature system's potentially greater susceptibility.[22] Additionally, in accordance with the ATSDR's *Child Health Initiative*[31] and the EPA's *National Agenda to Protect Children's Health from Environmental Threats,*[32] the DSHS further seeks to protect children from the possible negative effects of toxicants in fish by suggesting that this potentially sensitive subgroup consume smaller quantities of contaminated fish or shellfish than adults consume. Thus, DSHS recommends that children weighing 35 kg or less and/or who are 11 years of age or younger limit exposure to contaminants in fish or shellfish by eating no more than four ounces per meal of the contaminated species. The DSHS also recommends that consumers spread these meals over time. For instance, if the DSHS issues consumption advice that suggests consumption of no more than two meals per month of a contaminated species, those children should eat no more than 24 meals of the contaminated fish or shellfish per year and, ideally, should not eat such fish or shellfish more than twice per month.

RESULTS

Laboratory Analytical Results

The GERG laboratory submitted electronic copies of the results of laboratory analyses of chemicals in the Lake Como samples to the DSHS in September 2006. The laboratory analyzed 10 fish for seven metal-like constituents: arsenic, cadmium, copper, mercury, lead, selenium, zinc, and for pesticides and PCBs. The laboratory also analyzed two of those same samples for semivolatile organic compounds (SVOCs) and volatile organic compounds (VOCs).

Table 1 presents the species collected, along with length and weight. Raw data are available from the SALG upon request.

Inorganic Contaminants

Arsenic, Cadmium, Copper, Lead, Mercury, Selenium, and Zinc

Inorganic contaminants/constituents such as arsenic, copper, lead, mercury, selenium, and zinc were present in one or more fish at concentrations of no significance to human health. Arsenic was present in nine of ten fish examined (Table 2a) and reported below the laboratory's method detection limit (MDL) as an estimated “J” concentration in one channel catfish. The laboratory identified no cadmium at levels above the MDL in any fish. Two fish contained lead at concentrations below the laboratory's reporting limit (MDL in this case) as indicated by use of estimated “J” concentrations in the two samples (Table 2b). Mercury was present in all samples examined (Table 2b). The average concentration of mercury in largemouth bass from Como Lake was 0.228±0.044 mg/kg (Table 2b). A largemouth bass contained the highest mercury concentration (0.294 mg/kg). That bass was 436 mm long and weighed 1262 grams. The mean mercury concentration in all fish combined was 0.192±0.086 mg/kg (Table 2b).

Copper, selenium, and zinc (all of which are essential micronutrients for humans) were present in all fish, as is often observed (Tables 2b, 2c). Ten of ten samples contained copper at levels reported above the MDL. The mean copper concentration for all fish was 0.209±0.175 mg/kg (Table 2b). In the ten fish analyzed, selenium averaged 0.226±0.044 mg/kg (Table 2c). The mean zinc concentration in the 10 fish was 5.525±3.308 mg/kg (Table 2c).

Organic Contaminants

The GERG laboratory analyzed ten of ten fish tissue samples collected from Lake Como for commonplace and/or legacy pesticides and PCBs. The laboratory also analyzed two of 10 fish (channel catfish and common carp) for SVOCs and VOCs.

Pesticides

Thirty-four pesticides were included in the laboratory’s analysis of fish collected in 2005 from Lake Como. The pesticides were representative of legacy and/or major pesticide groups such as organochlorines, organophosphates, and carbamates. Most fish contained trace[d] quantities of 4,4’-DDD, 4,4'-DDE, and 4,4'-DDT (Table 3a). Chlordane was present in all fish at trace levels (mean concentration = 0.036 ± 0.023 mg/kg; Table 3b). Dieldrin was measurable in eight samples and appeared at levels below the detection limit in two samples. A few pesticides, such as pentachloroanisole (for which there is no RfD or cancer slope factor), pentachlorobenzene, and hexachlorobenzene were observed sporadically at levels below the method detection limit. No other pesticides were reported present in fish from Lake Como.

VOCs

Trace quantities of acetone, 1, 2-dichloroethane, naphthalene, n-propylbenzene, and toluene were observed in one or two fish examined (data not presented). Methylene chloride was present in the channel catfish (0.074 mg/kg) and the common carp (0.085 mg/kg) at levels below the MDL. The channel catfish contained carbon disulfide reported below the laboratory’s MDL, while the common carp contained 0.067 mg/kg of carbon disulfide. However, acetone, 1,2-dichloroethane, methylene chloride, and naphthalene were also identified in the procedural blanks, an indication, perhaps, of laboratory or sample-handling contamination. Concentrations reported in fish

[d] Trace: an extremely small amount of a chemical compound, one present in a sample at a concentration below a standard limit. Trace quantities may be designated in the data with the “less than” (<) sign or may also be represented by the alpha character “J” – called a “J-value” defining the concentration of a substance as near zero or one that is detected at a low level but that is not guaranteed quantitatively replicable.

samples were usually higher than those in the procedural blank. These contaminants also could have been byproducts of sample necrosis (data not presented).

SVOCs

The laboratory analyzed two fish (channel catfish, common carp) for 123 SVOCs, identifying only one compound – bis (2-ethylhexyl) phthalate. Concentrations of this ubiquitous plasticizer were below the laboratory MDL in both fish

PCBs

Footnote "a" of this report explains the changeover to measuring PCB congeners instead of Aroclors. For Lake Como, this study marks the first analysis of PCB congeners rather than Aroclors. Thus, comparison of PCBs among risk characterizations might be difficult. However, the congener analysis is particularly sensitive. Therefore, the low PCB levels in the 2005 fish from Lake Como should be accurate. That is, the differences between laboratories should not be responsible for differences between PCB concentrations from year to year. Changes in the quantitative evaluation the carcinogenic potential of PCBs have also occurred over time. As described in the methods section, PCBs were measured in 8 largemouth bass (0.016 ±0.007 mg/kg), 1 channel catfish (0.019 mg/kg), and 1 common carp (0.028 mg/kg). The grand mean ± the standard deviation for PCBs in the ten fish from Lake Como, across all species was 0.018±0.007 mg/kg.

DISSCUSSION

Risk Characterization

The actual risk of adverse health outcomes from exposure to toxicants based on experimental or epidemiological data is subject to the known variability of individual and population responses. Thus, calculated risks can be orders of magnitude above or below the actual risks of systemic or local effects of toxicants. The variability depends upon many factors: the target organ; the species of animal used in the study; different exposure periods; different doses; or other variations in conditions.[22] Nevertheless, the DSHS calculated a number of risk parameters for potential toxicity to humans who consume contaminated fish from Lake Como. Conclusions and recommendations predicated upon the stated goal of the DSHS to protect human health follow this discussion of findings.

Characterization of Possible Systemic (Noncancerous) Health Effects Related to Consumption of Fish from Lake Como

The SALG risk characterization revealed no toxicologically significant inorganic or organic contaminant concentrations in fish tissue samples collected in 2005 from Lake Como (Tables 2a, 2b, 2c, 3). Although all fish (largemouth bass, channel catfish, and a common carp) contained some PCBs, no concentration reached the HAC_{nonca} for PCBs. Table 4 shows the calculated hazard quotients for PCBs in fish from Lake Como. No HQ was greater than 1.0, while number of meals suggested for adults weighing 70 kilograms or more does exceed 1 meal per week for systemic health effects, DSHS' guidance for protecting human health. Therefore, people who regularly eat fish from Lake Como should not experience noncancerous or systemic health effects.

Characterization of the Possibility of Excess Lifetime Cancer Risk from Consumption of Fish from Lake Como

Cancer risk is complex and is seldom a straightforward subject. Conclusions from calculations of theoretical lifetime excess cancer risks must be tempered by the known variability of risk calculations. Actual risk may be much lower or much higher than calculated, varying by orders of magnitude from the calculated risk.[22] Risk of cancer from involuntary exposure to environmental contaminants likely contributes only modestly to lifetime risk of cancer.[33] Nevertheless, that risk is likely real and must be addressed.

People may reduce their risk of cancer from certain exposures by modifying behaviors. In the instance of cancer causing contaminants in fish, reducing consumption of contaminated fish may decrease the lifetime theoretical risk of cancers. To assist with informed decisions about the risk of exposure to carcinogens in fish or shellfish, the SALG analyzes these foods for cancer-causing chemicals, evaluates theoretical risk from exposure to contaminants in fish or shellfish, and communicates those risks to people so they can control exposure by changing their consumption habits, should they wish.

The average concentration of PCBs in fish collected from Lake Como in 2005 was 0.018 mg/kg (minimum concentration=0.008; maximum concentration= 0.029 mg/kg) in a largemouth bass. The second highest concentration was 0.027 mg/kg, in the common carp. No fish concentration of PCBs approached the HAC_{ca} for PCBs, which is 0.272 mg/kg. The highest concentration seen was only 1/10 the HAC_{ca}. It is not likely, thus, that people regularly eating fish from Lake Como would have an increase in their calculated excess lifetime cancer risk.

No fish from Lake Como contained inorganic or organic contaminants at concentrations that were likely to cause the theoretical lifetime risk of cancer to exceed DSHS guideline of 1 excess cancer in 10,000 equally exposed individuals who consume fish from Lake Como.

Characterization of Cumulative Systemic Health Effects and Cumulative Excess Lifetime Cancer Risk from Consumption of Fish from Lake Como

Risk assessment guidelines from the USEPA suggest estimates of adverse systemic health effects of toxicants with similar modes or mechanisms of action or those toxicants that attack the same target organ (e.g., the liver) may be additive. Therefore, risk assessors often sum risks from individual chemicals to obtain an estimate of overall risk to those simultaneously exposed to two or more contaminants.[34, 35] Similarly, summation of calculated theoretical excess risks of cancer is appropriate if the agent causes cancer by the same mode or mechanism of action (e.g., tumor initiator, tumor promoter, or enzyme inducer). The DSHS uses these general guidelines for assessing the likelihood of cumulative systemic effects or cancer in people exposed to multiple contaminants in the same fish.

No single contaminant in fish from Lake Como increased the likelihood of systemic or carcinogenic health outcomes in people who eat fish from this lake. Nonetheless, since several observed compounds can cause cancer or because they affect the same target organ (the liver) SALG risk assessors examined the possibility that simultaneous exposure to several contaminants would result in an increase in the likelihood of systemic effects or would raise the lifetime excess cancer risk in people eating fish from Lake Como. SALG risk assessors found no such increase in the lifetime excess cancer risk with simultaneous exposure to more than one contaminant (data not presented). This exposure scenario also does not increase the risk of systemic adverse health outcomes in those who would regularly consume fish from Lake Como (data not presented).

Conclusions

SALG risk assessors prepare risk characterizations to determine public health hazards from consumption of fish and shellfish harvested from Texas water bodies by recreational or subsistence fishers, and – if indicated – may suggest strategies for reducing risk to the health of those who eat contaminated fish or seafood to risk managers at DSHS, including the Texas Commissioner of Health.

This study addressed the public health implications of consuming fish from Lake Como. Risk assessors from the SALG and the Environmental and Injury Epidemiology and Toxicology Branch (EIETB) conclude from the present characterization of potential adverse health effects from consuming contaminated fish from Lake Como.

1. That fish collected from Lake Como do not contain mercury in excess of DSHS guidelines for protection of human health. Thus, consumption of fish from Lake Como that contain small quantities of mercury poses **no apparent public health hazard.**

2. That fish collected from Lake Como do not contain arsenic, cadmium, copper, lead, selenium, or zinc at concentrations in excess of DSHS guidelines for protection of human health. Thus, consumption of fish from Lake Como that contain small quantities of inorganic components – some of which are essential nutrients – poses **no apparent public health hazard.**

3. That fish collected from Lake Como in 2005 do not contain PCBs at concentrations of significance to human health, either singly or in combination with other organic compounds. Therefore, consumption of fish from this small urban storm-water retention pond that contain small quantities of PCBs similar to those observed in samples collected in late 2005 should pose **no apparent public health hazard.**

4. That fish collected from Lake Como do not contain pesticides, SVOCS, or VOCs at concentrations of significance to human health, either singly or in combination with other such compounds. Thus, consumption of fish from Lake Como containing small quantities of organic contaminants – with or without other contaminants – should pose **no apparent public health hazard.**

Recommendations

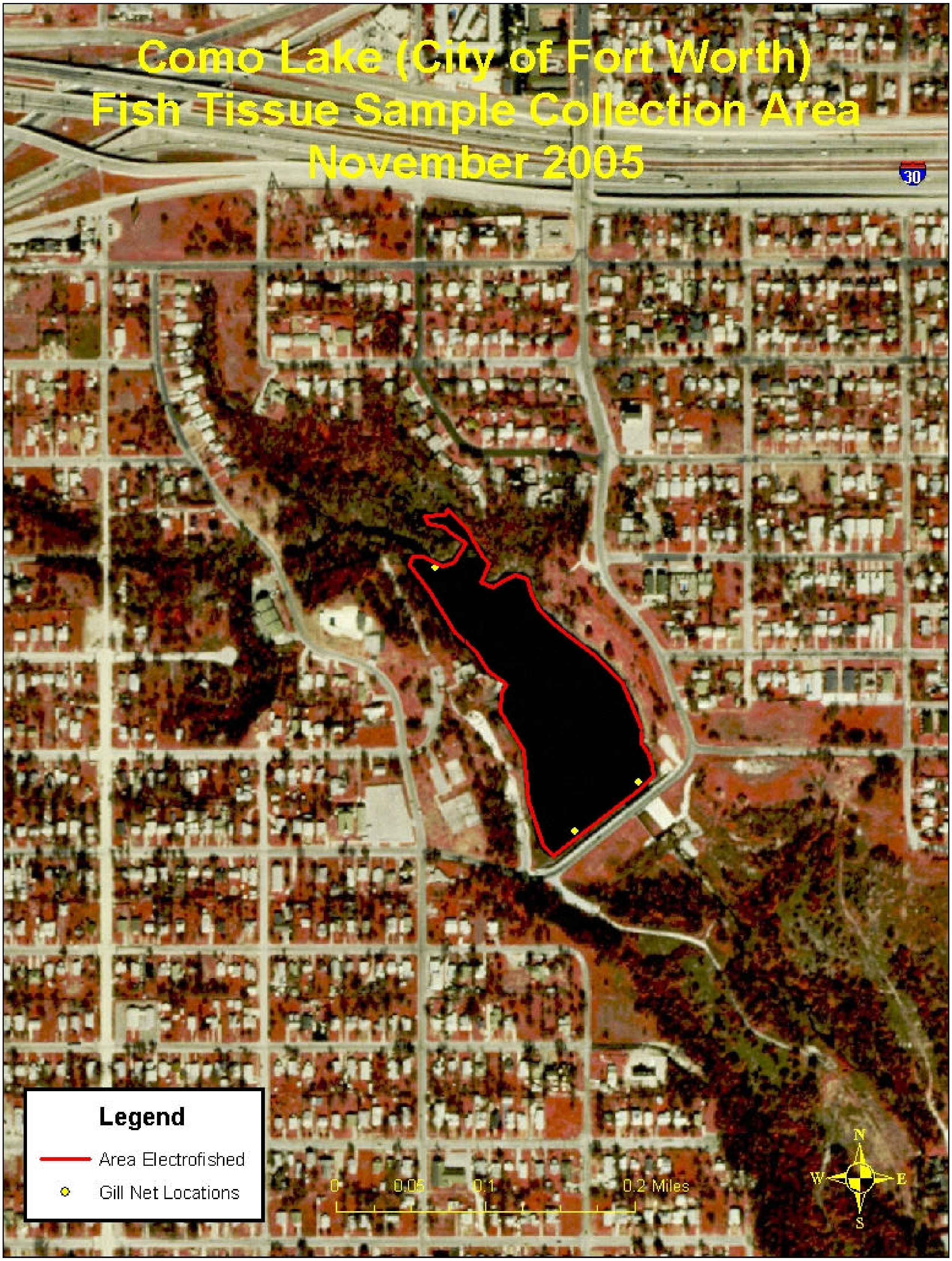
Risk managers at the DSHS have established criteria for issuing fish consumption advisories based on approaches suggested by the USEPA.[9] Confirmation through risk characterization that consumption of four or fewer meals per month (adults: eight ounces per meal; children: four ounces per meal) of fish or shellfish from a specific water body would result in exposures to toxicants in excess of DSHS health-based guidelines might lead managers to recommend consumption advice for fish or shellfish from the water body. As an alternative, the department may ban possession of fish from the affected water body. Fish or shellfish possession bans are enforceable under subchapter D of the Texas Health and Safety Code, part 436.061(a).[36] Declarations of prohibited harvesting areas are enforceable under subchapter D of the Texas Health and Safety Code, part 436.091 and 436.101.[36] DSHS consumption advisories carry no penalties for noncompliance, but, instead, inform the public of health hazards from consuming contaminated fish or shellfish from Texas waters. With such information, that members of the public can make informed decisions about eating contaminated fish or shellfish. In the 2002 risk characterization, the results of the 2002 risk characterization were similar to those of this risk characterization. However, for the 2005 risk characterization, the SALG staff fulfilled the suggestion made in 2002 that fish species other than largemouth bass be collected (albeit, staff caught only one channel catfish and one common carp during the 2005 sampling trip). Even with the addition of two other species, observed concentrations of toxicants were of no significance to human health. Thus, the SALG and the EIETB of DSHS conclude from this risk characterization that consuming fish from Lake Como poses **no apparent hazard to public health**. Based on this observation, the SALG and the EIETB recommend

1. That the DSHS rescind Aquatic Life Order # 10 (AL-10) that presently prohibits the possession of fish from Lake Como because consumption of fish from this lake no longer appears to pose any undue risks to human health.

Public Health Plan

Communication of possession bans, consumption advisories – or the removal of either – to the public is essential to effective risk management. In fulfillment of the responsibility for communication, the Texas Department of State Health Services (DSHS) takes several steps. The agency irregularly publishes fish consumption advisories and bans in a booklet available to the public through the Seafood and Aquatic Life Group (SALG). To receive the booklet and/or the data, please contact the SALG at 1-512-834-6757.[37] The SALG also posts the most current information about advisories, bans, and the repeal of such on the Internet at http://www.dshs.state.tx.us/seafood. The SALG regularly updates this web site with current information. The Texas Department of State Health Services also provides the U.S. Environmental Protection Agency (http://epa.gov/waterscience/fish/advisories/), the Texas Commission on Environmental Quality (TCEQ; http://www.tceq.state.tx.us), and the Texas Parks and Wildlife Department (TPWD; http://www.tpwd.state.tx.us) with information on all consumption advisories, possession bans, or repealed advisories and bans. Each year, on its Web site, the TPWD informs the fishing and hunting public of consumption advisories and fishing bans on its Web site and in an official hunting and fishing regulations booklet available at many state parks and at all establishments selling Texas fishing licenses.[38] Readers may direct questions about the scientific information or recommendations in this risk characterization to risk managers at the Seafood and Aquatic Life Group (SALG) at 1-512-834-6757 or may find the information at the SALG's website (http://www.dshs.state.tx.us/). Secondarily, one may address inquiries to the Environmental and Injury Epidemiology and Toxicology Branch of the Department of State Health Services (1-512-458-7269). The EPA's IRIS Web site (http://www.epa.gov/iris/) contains much information on environmental contaminants found in food and environmental media. The Agency for Toxic Substances and Disease Registry (ATSDR), Division of Toxicology (1-888-42-ATSDR or 1-888-422-8737 or the ATSDR's Web site (http://www.atsdr.cde.gov) supplies brief information via ToxFAQs.® ToxFAQs® are available on the ATSDR website in either English (http://www.atsdr.cdc.gov/toxfaq.html) or Spanish (http://www.atsdr.cdc.gov/es/toxfaqs/es _toxfaqs.html). The ATSDR also publishes more in-depth reviews of many toxic substances in its *Toxicological Profiles.* To request a copy of available *Toxicological Profiles*, readers may telephone the ATSDR at 1-404-498-0261 or email requests to atsdric@cdc.gov. Many Toxicological Profiles are also available for downloading at ATSDR's website.

FIGURE 1. Lake Como Map November, 2005.



TABLES

Table 1: Fish Collected from Lake Como between November 1 and November 3, 2005. Staff Recorded Sample Number, Species, Length, and Weight for Each Sample Collected from Four Sites within the Reservoir.				
Date	**Sample Number**	**Species**	**Length (mm)**	**Weight (g)**
11/01/05 thru 11/03/05	COM1	Largemouth Bass	443	1534
	COM2	Largemouth Bass	458	1577
	COM3	Largemouth Bass	460	1878
	COM4	Largemouth Bass	436	1262
	COM5	Largemouth Bass	427	1357
	COM6	Largemouth Bass	428	1338
	COM7	Largemouth Bass	418	1190
	COM8	Largemouth Bass	397	1022
	COM9	Channel Catfish	590	2730
	COM10	Common Carp	608	3509

Table 2a. Arsenic (mg/kg) in Fish from Lake Como, 2005.					
Species	**# Detected/ # Sampled**	**Total Arsenic Mean Concentration ± S.D. (Min-Max)**	**Inorganic Arsenic Mean Concentration[e]**	**Health Assessment Comparison Value (mg/kg)[f]**	**Basis for Comparison Value**
Channel catfish	1/1	BDL[g]	**BDL[g]**	0.7 0.362	EPA chronic oral RfD for Inorganic arsenic: 0.0003 mg/kg–day EPA oral slope factor for inorganic arsenic: 1.5 per mg/kg–day
Common carp	1/1	0.070	**0.007**		
Largemouth bass	8/8	0.058 ± 0.012 (0.040-0.072)	**0.006**		
All Fish Combined	10/10	0.055 ± 0.019 (BDL-0.072)	**0.006**		

[e] Most arsenic in fish and shellfish occurs as organic arsenic, considered virtually nontoxic. For risk assessment calculations, DSHS assumes that total arsenic is composed of 10% inorganic arsenic in fish and shellfish tissues.

[f] Derived from the MRL or RfD for noncarcinogens or the USEPA slope factor for carcinogens. Assumes a body weight of 70 kg and a consumption rate of 30 grams per day, and, for carcinogens, a 30-year exposure period and a lifetime excess cancer risk of 1E-4 (1 in 10,000 exposed individuals).

[g] BDL: "Below Detection Limit" – Concentrations were reported as less than the laboratory's method detection limit ("J" values). In some instances, a "J" value was used to denote the discernable presence in a sample of a contaminant at concentrations estimated as different from the sample blank, while at other times, a "<" followed by the laboratory's MDL was utilized to note that a contaminant was detected below the detection limit, but was not quantified.

Table 2b. Inorganic Contaminants (mg/kg) in Fish from Lake Como, 2005.				
Contaminant	**# Detected/ # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)[f]**	**Basis for Comparison Value**
Cadmium				
Channel catfish	0/1	ND[h]	0.47	ATSDR chronic oral MRL: 0.0002 mg/kg–day
Common carp	0/1	ND		
Largemouth bass	0/8	ND		
All Fish Combined	0/10	ND		
Copper				
Channel catfish	1/1	0.181	333	National Academy of Science Upper Limit: 0.143 mg/kg–day
Common carp	1/1	0.541		
Largemouth bass	8/8	0.172 ± 0.149 (0.094-0.538)		
All Fish Combined	10/10	0.209 ± 0.175 (0.094-0.541)		
Lead				
Channel catfish	0/1	ND[h]	0.6	EPA IEUBKwin[c]
Common carp	1/1	BDL[g]		
Largemouth bass	1/8	BDL		
All Fish Combined	2/10	BDL		
Mercury				
Channel catfish	1/1	0.077	0.7	ATSDR chronic oral MRL: 0.0003 mg/kg–day
Common carp	1/1	0.019		
Largemouth bass	8/8	0.228 ± 0.044 (0.186-0.294)		
All Fish Combined	10/10	0.192 ± 0.086 (0.019-0.294)		

[h] *ND: "Not Detected"- used to indicate that a compound was not present in a sample at a concentration greater than the method detection limit (MDL).*

Table 2c. Inorganic Contaminants (mg/kg) in Fish from Lake Como, 2005.				
Contaminant	**# Detected/ # Sampled**	**Mean Concentration ± S.D. (Min-Max)**	**Health Assessment Comparison Value (mg/kg)[f]**	**Basis for Comparison Value**
Selenium				
Channel catfish	1/1	0.146	6	EPA chronic oral RfD: 0 .005 mg/kg–day ATSDR chronic oral MRL: 0.005 mg/kg–day NAS UL: 0.400 mg/day (0.005 mg/kg–day) RfD or MRL/2: (0.005 mg/kg –day/2= 0.0025 mg/kg–day) to account for other sources of selenium in the diet
Common carp	1/1	0.198		
Largemouth bass	8/8	0.239 ± 0.36 (0.214-0.322)		
All Fish Combined	10/10	0.226 ± 0.044 (0.146-0.322)		
Zinc				
Channel catfish	1/1	4.519	700	EPA chronic oral RfD: 0.3 mg/kg–day
Common carp	1/1	14.821		
Largemouth bass	8/8	4.488 ± 0.590 (3.292-5.391)		
All Fish Combined	10/10	5.525 ± 3.308 (3.292-14.821)		

Table 3a. Organic Contaminants (mg/kg) in Fish Collected in 2005 from Lake Como.

Contaminant	# Detected / # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)[f]	Basis for Comparison Value
PCBs				
Channel catfish	1/1	0.019	0.047 0.272	EPA chronic oral RfD: 0.00002 mg/kg–day EPA slope factor: 2.0 per mg/kg–day
Common carp	1/1	0.028		
Largemouth bass	8/8	0.016 ± 0.007 (0.008-0.029)		
All Fish Combined	10/10	0.018 ± 0.007 (0.008-0.029)		
4, 4' DDD				
Channel catfish	1/1	0.066	1.167 2.27	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor: 0.24 per mg/kg–day
Common carp	1/1	0.010		
Largemouth bass	8/8	0.002 ± 0.001 (BDL-0.004)		
All Fish Combined	10/10	0.009 ± 0.020 (BDL-0.066)		
4, 4' DDE				
Channel catfish	1/1	0.130	1.167 1.6	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor: 0.34 per mg/kg–day
Common carp	1/1	0.023		
Largemouth bass	8/8	0.008 ± 0.004 (0.004-0.015)		
All Fish Combined	10/10	0.022 ± 0.038 (0.004-0.130)		
4, 4' DDT				
Channel catfish	1/1	0.160	1.167 1.6	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor: 0.34 per mg/kg–day
Common carp	0/1	ND		
Largemouth bass	8/8	**BDL**		
All Fish Combined	9/10	0.017 ± 0.050 (ND-0.160)		
Total DDT-Like Compounds (DDE+DDD+DDT)				
Channel catfish	1/1	0.355	1.167 1.6	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor: 0.34 per mg/kg–day
Common carp	1/1	0.034		
Largemouth bass	8/8	0.012 ± 0.004 (0.006-0.019)		
All Fish Combined	10/10	0.048 ± 0.108 (0.006-0.355)		

Table 3a. Organic Contaminants (mg/kg) in Fish from Lake Como, 2005.

Contaminant	# Detected / # Sampled	Mean Concentration ± S.D. (Min-Max)	Health Assessment Comparison Value (mg/kg)[f]	Basis for Comparison Value
Chlordane				
Channel catfish	1/1	0.057	1.167 1.53	EPA chronic oral RfD: 0.0005 mg/kg–day EPA slope factor: 0.35 per mg/kg–day
Common carp	1/1	0.086		
Largemouth bass	8/8	0.027±0.013 (0.013-0.050)		
All Fish Combined	10/10	0.036±0.023 (0.013-0.086)		
Dieldrin				
Channel catfish	1/1	0.031	0.117 0.034	EPA chronic oral RfD: 0.00005 mg/kg–day EPA slope factor: 16 per mg/kg–day
Common carp	0/1	ND		
Largemouth bass	7/8	0.008 ± 0.006 (ND-0.020)		
All Fish Combined	8/10	0.009 ± 0.009 (ND-0.031)		
Common carp	1/1	BDL		
Largemouth bass	1/8	BDL		
All Fish Combined	3/10	BDL		

Table 4 Hazard quotients (HQ) for PCBs in fish collected from Lake Como in 2005. Table 4 also provides suggested consumption rates in for adults who eat 8-oz of fish per meal containing PCBs at concentrations near those found in the 2005 samples.[i]

Species/Contaminant	Hazard Quotient	Meals per Week
Channel catfish	0.41	2[j]
Common carp	0.59	2
Largemouth bass	0.35	3
All Fish Combined	0.38	2.5

[i] DSHS assumes that children under the age of 12 years and/or those who weigh less than 35 kg eat 4-ounce meals.

Table 5. Theoretical lifetime excess cancer risk for each species assessed calculated from 2005 data for consumption of PCB-contaminated fish from Lake Como. The table suggests weekly eight-ounce meal consumption rates for 70-kg adults who eat each species of fish.[i]

Species/Contaminant	Theoretical Lifetime Excess Cancer Risk		Meals per Week
	Risk	1 excess cancer per number of people exposed	
Channel catfish	6.5E-06	154,848	14[j]
Common carp	1.0E-05	98,954	9
Largemouth bass	5.9E-06	168,350	16
All Fish Combined	6.3E-06	154,848	14

[j]DSHS assumes that people who eat species for which the calculated number of meals per week exceeds 1.0 need not limit their consumption of those species.

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